EXPERIMENT -

Hypothesis - Trying to model the dataset to accurately process transaction data in the order of likelihood

Design - Here the accuracy is calculated based on F1 score, ROC curves

Author Name - Amith K A

Time for the Experiment - 12 Hours

Total run time of Notebook - 61.578125 seconds

System - Windows, 4 Core, 16 GB

Release - 10

Version - 10.0.19041

Machine - AMD64

Processor - Intel64 Family 6 Model 158 Stepping 9, GenuineIntel

Pointers for the experiment

- EDA is performed, based on this the features that hold no significance is removed
- The EDA I would perform on the dataset is "To-the-book" or very basic to say the least as no domain coverage has been shared
- I would be running a few different models and the following notebook would have all details
- Finally, I would be picking one model out of the various interations run based on personal discretion

STEPS

1. Importing the necessary packages, **Status** - *Done*
2. EDA - Descriptive stats, **Status** - *Done*
3. EDA - Correlation analysis, **Status** - *Done*
4. EDA - Missing value treatment, **Status** - *Not Required*
5. EDA - Outlier analysis, **Status** - *Not required*
6. Modelling, Random Forest, **Status** - *Done*
7. PCA Analysis performed, This was not a good measure, **Status** - *Done*
8. Evaluation, **Status - 6 Models -** - *Done*
9. Alternative methods, **Status** - *Done*
10. Final Inference, **Status** - *Done*

ASSUMPTIONS

For the interest of time, different iterations have not been assessed

```
- We have no missing values or the 0 indicated in columns does not suggest the value is mi
ssing
- The data provided is sufficnet enough to make a baseline model
- As per Occam's razor, we are electing the simplistic model. Complex versions involving L
STMs or Deep neural networks is not used here
```

In [1]:
```
#Importing the necessary libraries
```

In [2]:
```
import pandas as pd
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.decomposition import PCA
import warnings
import pickle
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score
warnings.filterwarnings('ignore')
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
import seaborn as sns; sns.set_theme()
from imblearn.over_sampling import SMOTE
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
import scikitplot as skplt
```

In [224]:
```
# import types
# def imports():
#     for name, val in globals().items():
#         if isinstance(val, types.ModuleType):
#             yield val.__name__
# list(imports())
```

In [223]:
```
#print('\n'.join(f'{m.__name__} {m.__version__}' for m in globals().values() if getattr(m, '__version__', None))
```

In [4]:
```
DF=pd.read_csv("./Desktop/Tide_test_DS/Tide_test_DS/data_interview_test.csv",sep=":")
```

In [5]:
```
DF.describe()
```

Out[5]:

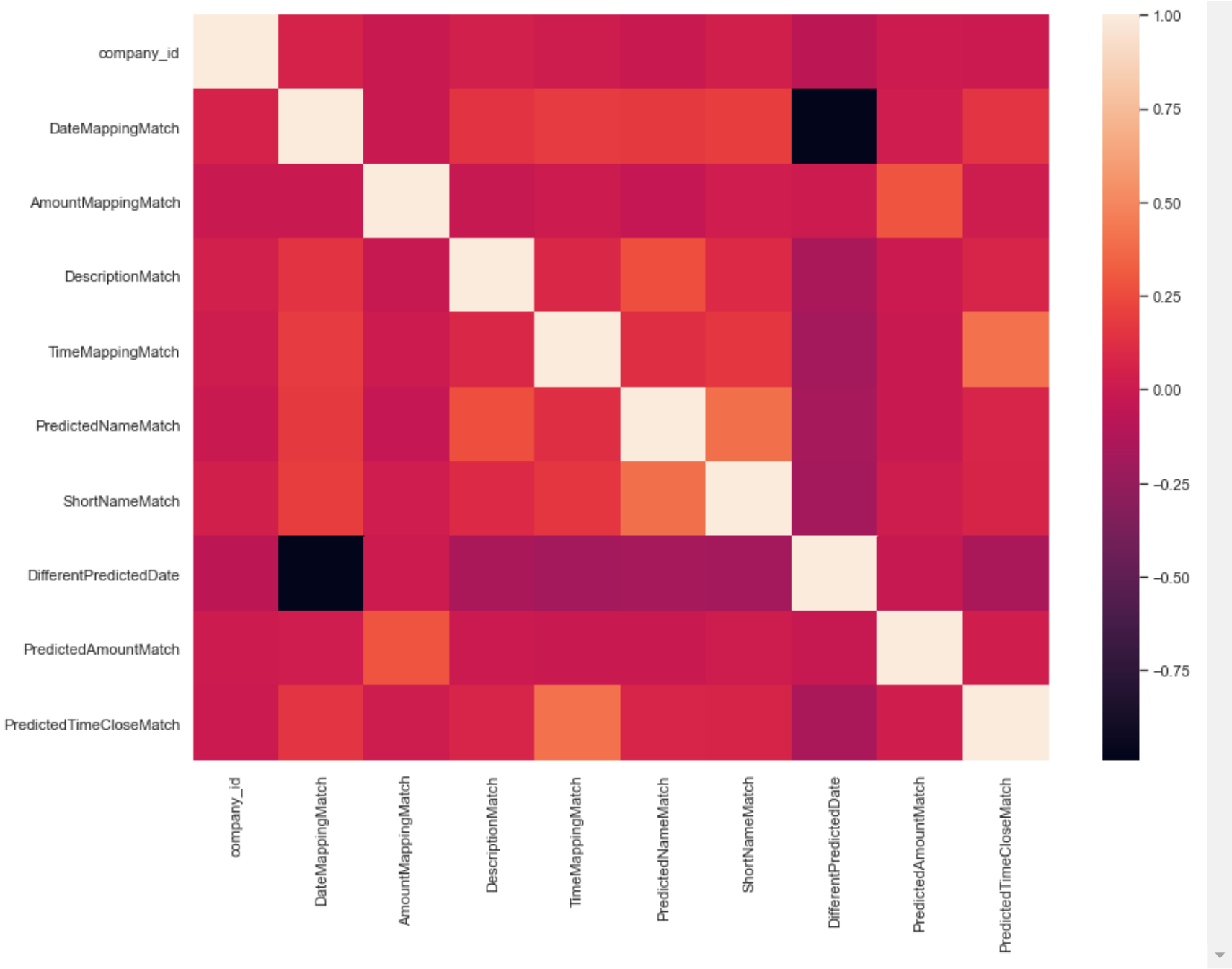
	company_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	DifferentPredictedTime	TimeMappingMatch	PredictedNar
count	12034.000000	12034.000000	12034.000000	12034.000000	12034.000000	12034.000000	1203
mean	27247.797906	0.217901	0.031660	0.021522	0.986455	0.013877	
std	12024.542988	0.384535	0.122611	0.116995	0.115597	0.116987	
min	10000.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
25%	20000.000000	0.000000	0.000000	0.000000	1.000000	0.000000	
50%	30000.000000	0.000000	0.000000	0.000000	1.000000	0.000000	
75%	30000.000000	0.000000	0.000000	0.000000	1.000000	0.000000	
max	50000.000000	1.000000	0.900000	0.800000	1.000000	1.000000	

In [6]:
```
# Removing "DifferentPredictedTime" as this is not a significant feature
```

In [7]:
```
DF.drop(columns="DifferentPredictedTime",inplace=True)
```

In [8]:
```
fig, ax = plt.subplots(figsize=(14,10))
sns.heatmap(DF.corr(), ax=ax)
```

Out[8]:
```
<AxesSubplot:>
```



In [9]:
```
# Conditioning the matched_transaction_id, feature_transaction_id, receipt_id
```

In [10]:
```
DF.matched_transaction_id=DF.matched_transaction_id.str.replace(',', '').astype(float)
```

In [11]:
```
DF.feature_transaction_id=DF.feature_transaction_id.str.replace(',', '').astype(float)
```

In [12]:
```
DF.receipt_id=DF.receipt_id.str.replace(',', '').astype(float)
```

EDA

- Based on just analysing the data, it can be seen that the following columns are identifiers for receipts

> matched_transaction_id

> feature_transaction_id

> receipt_id

- They are however stored as strings and they need to be stored as numbers - We are converting them to float

---

- The following columns are stored as some sort of probability score of how likely a feature id matched. Eg - PredictedTimeCloseMatch of .4 would give 40% match

> AmountMappingMatch

> PredictedNameMatch

> PredictedAmountMatch

DescriptionMatch

DateMappingMatch

- The range specified in some of these columns are different and not stable.
- For instance, we need to account for stable ranges this is done by Binning

---

- The following Columns are binaries, i.e capable of holding either 0 or 1

DifferentPredictedDate

PredictedTimeCloseMatch

ShortNameMatch

TimeMappingMatch

- No missing value treatment needed as we do not have enough data which suggests that missing values could be zeros
- No outlier analysis needed here

In [13]:
```
# Converting columns to categories
```

In [14]:
```
Column_list=list(DF.columns[4:])
```

In [15]:
```
len(Column_list)
```

Out[15]:
```
9
```

In [16]:
```
Binaries = ['DifferentPredictedDate','PredictedTimeCloseMatch','ShortNameMatch','TimeMappingMatch']
```

In [17]:
```
Needed=list(set(Column_list)-set(Binaries))
```

In [18]:
```
for x in Binaries:
    DF[x]=DF[x].astype('category').cat.codes
```

In [19]:
```
Needed
```

Out[19]:
```
['PredictedAmountMatch',
 'PredictedNameMatch',
 'DateMappingMatch',
 'DescriptionMatch',
 'AmountMappingMatch']
```

Binning

- Illustration of binning. The idea here is that we cannot one hot encode - as we would be creating fixed labels.
- For instance for the column 'DateMappingMatch', the results can vary both in the training, validation and prediction data
- One hot encoding this column would give rise to a lot of unknowns and the ability to handle those unknowns can have a severe effect on the model

In [20]:
```
x='DateMappingMatch'
pd.cut(DF[x], bins=[-1, .4, .6, .8, 1]).value_counts().to_frame().reset_index().reset_index().rename({'level_0':
```

Out[20]:

	Codes	index	DateMappingMatch
0	0	(-1.0, 0.4]	9068
1	1	(0.8, 1.0]	2639
2	2	(0.6, 0.8]	218
3	3	(0.4, 0.6]	109

In [21]:
```
for x in Needed:
    DF[x]=pd.cut(DF[x], bins=[-1, .4, .6, .8, 1])
```

In [22]:
```
Needed
```

Out[22]:
```
['PredictedAmountMatch',
 'PredictedNameMatch',
 'DateMappingMatch',
 'DescriptionMatch',
 'AmountMappingMatch']
```

In [23]:
```
for x in Needed:
    DF[x]=DF[x].cat.codes
```

In [24]:
```
# Finding matching columns, to determine correct matches
```

In [25]:
```
DF[DF.matched_transaction_id==DF.feature_transaction_id].head(3)
```

Out[25]:

	receipt_id	company_id	matched_transaction_id	feature_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	T
25	10001.0	10000	10605.0	10605.0	3	0	0	
27	10002.0	10000	10286.0	10286.0	3	0	0	
38	10003.0	10000	10412.0	10412.0	3	0	0	

In [26]:
```
DF['Match'] = np.where(DF.matched_transaction_id==DF.feature_transaction_id, "Yes","No")
```

In [27]:
```
Lister_No=DF[DF.Match=="Yes"].matched_transaction_id
```

In [28]:
```
#Saving a base copy to run different iterations
```

In [29]:
```
DF_One=DF.copy()
```

==========

Classification model 1 - We are sampling one positive data point and 1 negative data point

==========

- Intent here is that our dataset is not balanced, and we are sampling and balancing it
- Random Forest model is used

In [30]:
```
DF=DF_One.copy()
```

In [31]:
```
List_me=[]
def Analysing(x,num):
    #print(Column_list[x])
    row=x.values[2]
    Delt=list(DF[DF.Match=="No"][DF[DF.Match=="No"].matched_transaction_id==row].head(num).index)
    #print(Delt)
    List_me.append(Delt)

    #DF[Column_list[x]].hist().plot
    #print(DF[Column_list[x]].value_counts())
```

In [32]:
```
DF[DF.Match=="Yes"].apply(Analysing, axis=1, num=1)
```

Out[32]:
```
25       None
27       None
38       None
73       None
105      None
         ...
11975    None
11980    None
11993    None
12006    None
12033    None
Length: 857, dtype: object
```

In [33]:
```
len(List_me)
```

Out[33]:
```
857
```

In [34]:
```
flat_list = [item for sublist in List_me for item in sublist]
```

In [35]:
```
flat_list_2=list(DF[DF.Match=="Yes"].index)
```

In [36]:
```
len(flat_list_2)
```

Out[36]:
```
857
```

In [37]:
```
len(flat_list_2)+len(flat_list)
```

Out[37]:
```
1690
```

In [38]:
```
len(flat_list)
```

Out[38]:
```
833
```

In [39]:
```
flat_list.extend(flat_list_2)
```

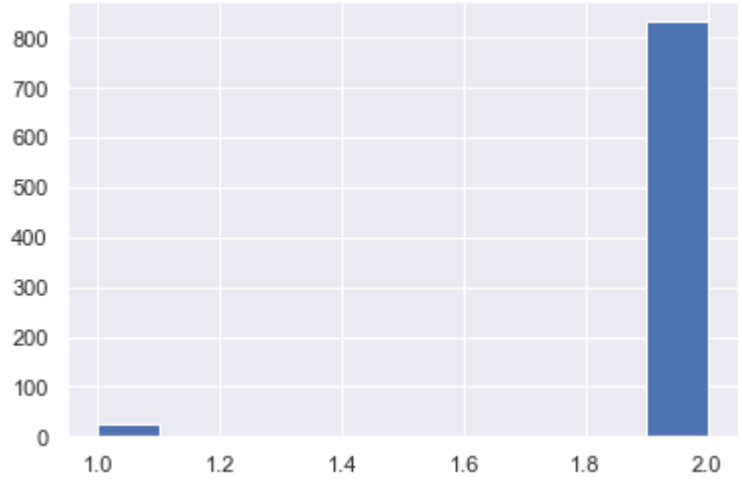
In [40]:
```
len(flat_list)
```

Out[40]: 1690

In [41]:
```
DF=DF[DF.index.isin(flat_list)]
```

In [42]:
```
DF.matched_transaction_id.value_counts().hist()
```

Out[42]: <AxesSubplot:>



In [43]:
```
len(list(set(DF[DF.Match=="Yes"].matched_transaction_id)))
```

Out[43]: 857

In [44]:
```
DF[DF.Match=="No"][DF[DF.Match=="No"].matched_transaction_id.isin(Lister_No)]
```

Out[44]:

	receipt_id	company_id	matched_transaction_id	feature_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch
20	10001.0	10000	10605.0	10596.0	0	0	0
28	10002.0	10000	10286.0	10287.0	3	0	0
34	10003.0	10000	10412.0	10140.0	0	0	0
62	10005.0	10000	10474.0	10461.0	0	0	0
97	10007.0	10000	10360.0	10348.0	0	0	0
...	...	...	...	...	...	...	..
11976	50221.0	50000	50034.0	50035.0	3	0	0
11979	50222.0	50000	50244.0	50243.0	3	0	0
11981	50223.0	50000	50342.0	50329.0	0	0	0
11995	50224.0	50000	50050.0	50038.0	0	2	0
12027	50226.0	50000	50368.0	50070.0	0	0	0

833 rows × 14 columns

In [45]:
```
#DF
```

In [46]:
```
#set(DF.matched_transaction_id)
```

In [47]:
```
#DF[DF.matched_transaction_id==10117]
```

In [48]:
```
DF_new=DF.copy()
```

In [49]:
```
DF.Match.value_counts()
```

Out[49]:
```
Yes    857
No     833
Name: Match, dtype: int64
```

In [50]:
```
DF.drop(columns="feature_transaction_id",inplace=True)
```

In [51]:
```
X=DF.iloc[:,:-1]
Y=DF.iloc[:,-1]
```

In [52]:
```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.30)
```

In [53]:
```
# smt = SMOTE(random_state=0)
# X_train_SMOTE, y_train_SMOTE = smt.fit_sample(X_train, y_train)
```

In [54]:
```
# X_train_SMOTE.shape,y_train_SMOTE.shape
```

In [ ]:
```

```

In [55]:
```
Final_Model = RandomForestClassifier()
```

In [56]:
```
Final_Model.fit(X_train,y_train)
```

Out[56]:
```
RandomForestClassifier()
```

In [57]:
```
print(f"Cross validation score of the model : {cross_val_score(Final_Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.9391489703989704
```

In [58]:
```
#Model.fit(X_train_SMOTE,y_train_SMOTE)
```

In [59]:
```
Predictions=Final_Model.predict(X_test)
```

In [60]:
```
X_test.columns
```

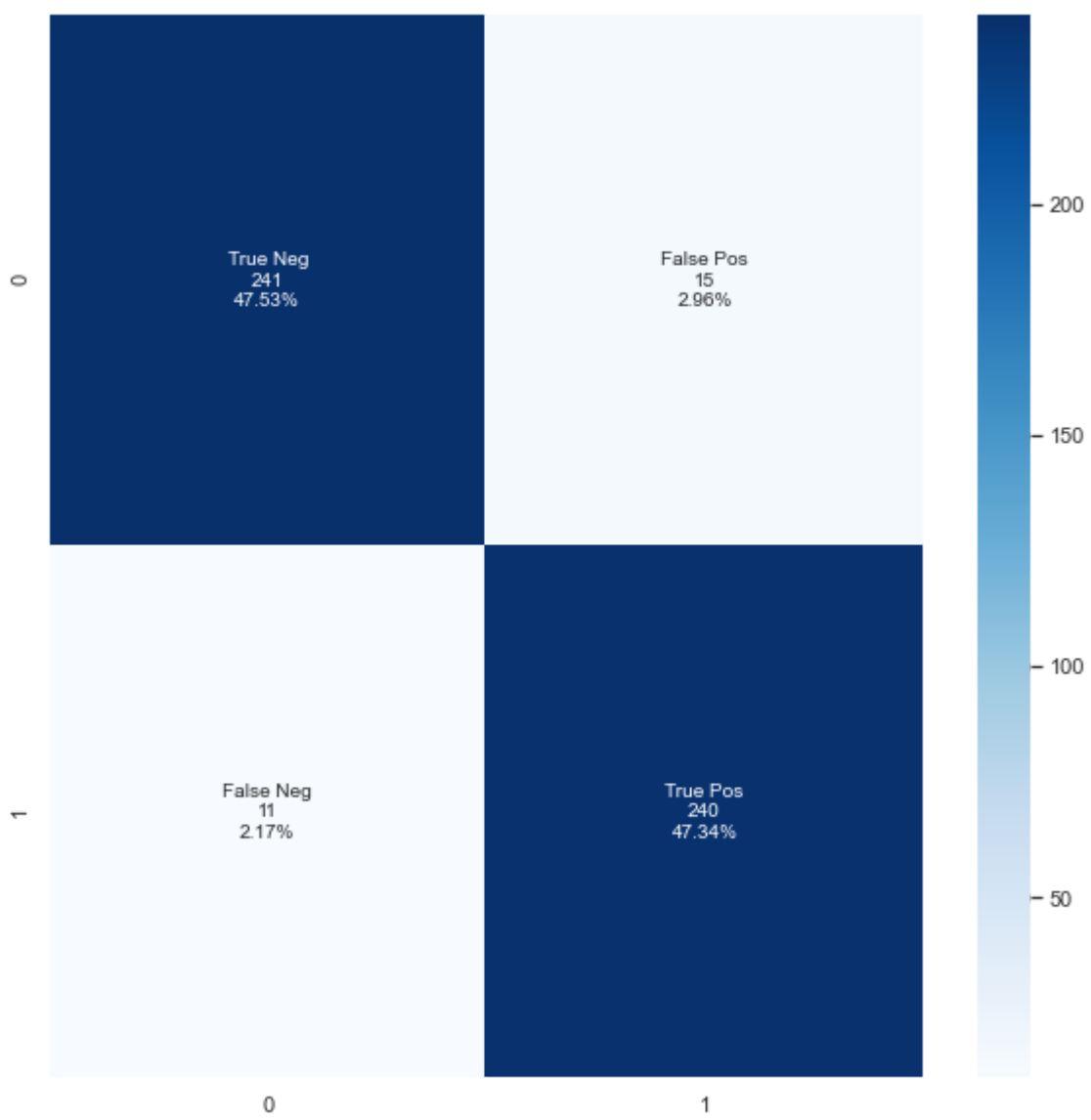
Out[60]:
```
Index(['receipt_id', 'company_id', 'matched_transaction_id',
       'DateMappingMatch', 'AmountMappingMatch', 'DescriptionMatch',
       'TimeMappingMatch', 'PredictedNameMatch', 'ShortNameMatch',
       'DifferentPredictedDate', 'PredictedAmountMatch',
       'PredictedTimeCloseMatch'],
      dtype='object')
```

In [61]:
```
cf_matrix = confusion_matrix(y_test, Predictions)
print(cf_matrix)
```

```
[[241  15]
 [ 11 240]]
```

In [62]:
```
fig, ax = plt.subplots(figsize=(10,10))
group_names = ["True Neg","False Pos","False Neg","True Pos"]
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten()/np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', ax=ax)
```

Out[62]:
```
<AxesSubplot:>
```


True Neg
241
47.53%
False Pos
15
2.96%
False Neg
11
2.17%
True Pos
240
47.34%
0
1
0
1
200
150
100
50

In [63]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

          No       0.96      0.94      0.95       256
         Yes       0.94      0.96      0.95       251

    accuracy                           0.95       507
   macro avg       0.95      0.95      0.95       507
weighted avg       0.95      0.95      0.95       507
```

In [64]:
```
Mapper={"Yes":1,"No":0}
```

In [65]:
```
y_test_temp=list(map(Mapper.get, y_test))
```

In [66]:
```
Predictions_temp=list(map(Mapper.get, Predictions))
```

In [67]:
```
This_1= roc_auc_score(y_test_temp, Predictions_temp)
```

In [68]:
```
print(f" AUC-ROC score is {This_1}")
```

```
 AUC-ROC score is 0.9487907744023905
```

In [69]:
```
fpr1, tpr1, _ = roc_curve(y_test_temp, Predictions_temp)
```

In [ ]:
```

```

==========

Classification model 2 - We are sampling one positive data point and 1 negative data point

==========

- Intent here is that our dataset is not balanced, and we are sampling and balancing it
- Random Forest model is used

In [70]:
```
DF=DF_new.copy()
```

In [71]:
```
DF.drop(columns='feature_transaction_id',inplace=True)
```

In [72]:
```
MappingMatch+DF.PredictedNameMatch+DF.ShortNameMatch+DF.DifferentPredictedDate+DF.PredictedAmountMatch+DF.Predict
```

In [73]:
```
DF=DF.sort_values(by=['matched_transaction_id','Weightage'],ascending=[True,False])
```

In [74]:
```
DF=DF[["receipt_id","company_id","matched_transaction_id","Weightage","Match"]]
```

In [ ]:
```

```

In [75]:
```
DF.Match.value_counts()
```

Out[75]:
```
Yes    857
No     833
Name: Match, dtype: int64
```

In [76]:
```
X=DF.iloc[:,:-1]
Y=DF.iloc[:,-1]
```

In [77]:
```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.30)
```

In [78]:
```
Model = RandomForestClassifier()
```

In [79]:
```
Model.fit(X_train,y_train)
```

Out[79]:
```
RandomForestClassifier()
```

In [80]:
```
print(f"Cross validation score of the model : {cross_val_score(Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.9272844272844273
```

In [81]:
```
Predictions=Model.predict(X_test)
```

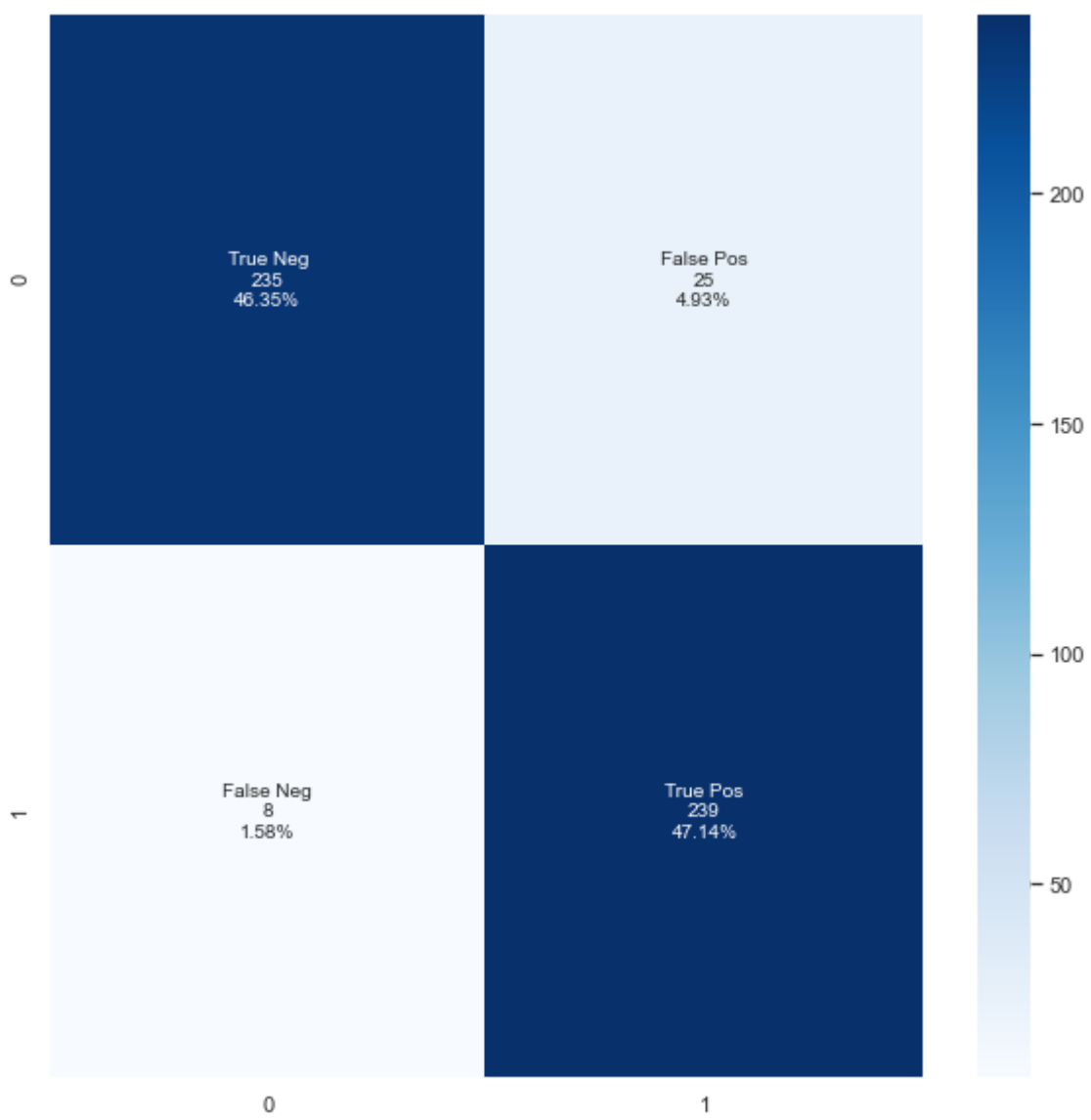
In [ ]:
```

```

In [82]:
```
cf_matrix = confusion_matrix(y_test, Predictions)
print(cf_matrix)
```

```
[[235  25]
 [  8 239]]
```

In [83]:
```
fig, ax = plt.subplots(figsize=(10,10))
group_names = ["True Neg","False Pos","False Neg","True Pos"]
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten()/np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', ax=ax)
```

Out[83]:
```
<AxesSubplot:>
```


True Neg
235
46.35%
False Pos
25
4.93%
False Neg
8
1.58%
True Pos
239
47.14%
0
1
0
1
200
150
100
50

In [84]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

          No       0.97      0.90      0.93       260
         Yes       0.91      0.97      0.94       247

    accuracy                           0.93       507
   macro avg       0.94      0.94      0.93       507
weighted avg       0.94      0.93      0.93       507
```

In [85]:
```
Mapper={"Yes":1,"No":0}
```

In [86]:
```
y_test_temp=list(map(Mapper.get, y_test))
```

In [87]:
```
Predictions_temp=list(map(Mapper.get, Predictions))
```

In [88]:
```
This_2= roc_auc_score(y_test_temp, Predictions_temp)
```

In [89]:
```
print(f" AUC-ROC score is {This_2}")
```

```
 AUC-ROC score is 0.9357287449392713
```

In [90]:
```
fpr2, tpr2, _ = roc_curve(y_test_temp, Predictions_temp)
```

In [ ]:
```

```

==========

Classification model 3 - We are sampling one positive data point and 2 negative data points

==========

- Intent here is that our dataset is not balanced, and we are sampling and balancing it (For each positive sample, 2 negative samples are chosen)
- Random Forest model is used

In [91]:
```
DF=DF_One.copy()
```

In [92]:
```
DF[DF.Match=="Yes"].apply(Analysing, axis=1, num=2)
```

Out[92]:
```
25       None
27       None
38       None
73       None
105      None
         ...
11975    None
11980    None
11993    None
12006    None
12033    None
Length: 857, dtype: object
```

In [93]:
```
len(List_me)
```

Out[93]:
```
1714
```

In [94]:
```
flat_list = [item for sublist in List_me for item in sublist]
```

In [95]:
```
flat_list_2=list(DF[DF.Match=="Yes"].index)
```

In [96]:
```
len(flat_list_2)
```

Out[96]:
```
857
```

In [97]:
```
len(flat_list_2)+len(flat_list)
```

Out[97]:
```
3292
```

In [98]:
```
len(flat_list)
```

Out[98]:
```
2435
```

In [99]:
```
flat_list.extend(flat_list_2)
```

In [100]:
```
len(flat_list)
```

Out[100]:
```
3292
```

In [101]:
```
DF=DF[DF.index.isin(flat_list)]
```

In [102]:
```
DF.Match.value_counts()
```

Out[102]:
```
No     1602
Yes     857
Name: Match, dtype: int64
```

In [103]:
```
DF.drop(columns="feature_transaction_id",inplace=True)
```

In [104]:
```
X=DF.iloc[:,:-1]
Y=DF.iloc[:,-1]
```

In [105]:
```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.30)
```

In [106]:
```
# smt = SMOTE(random_state=0)
# X_train_SMOTE, y_train_SMOTE = smt.fit_sample(X_train, y_train)
```

In [107]:
```
# X_train_SMOTE.shape,y_train_SMOTE.shape
```

In [ ]:
```

```

In [108]:
```
Model = RandomForestClassifier()
```

In [109]:
```
Model.fit(X_train,y_train)
```

Out[109]:
```
RandomForestClassifier()
```

In [110]:
```
print(f"Cross validation score of the model : {cross_val_score(Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.8965600775193798
```

In [111]:
```
#Model.fit(X_train_SMOTE,y_train_SMOTE)
```

In [112]:
```
Predictions=Model.predict(X_test)
```

In [113]:
```
X_test
```

Out[113]:

	receipt_id	company_id	matched_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	TimeMappingMatch
377	10032.0	10000	10302.0	0	0	0	0
257	10020.0	10000	10683.0	0	0	0	0
3782	20138.0	20000	20571.0	3	0	0	1
1063	10104.0	10000	10588.0	0	0	0	0
2478	20011.0	20000	20432.0	0	0	0	0
...	...	...	...	...	...	...	...
3872	20146.0	20000	20301.0	0	0	0	0
340	10028.0	10000	10279.0	0	0	0	0
3627	20120.0	20000	20541.0	0	0	0	0
10200	40152.0	40000	40498.0	3	0	0	0
3163	20071.0	20000	20305.0	3	0	0	0

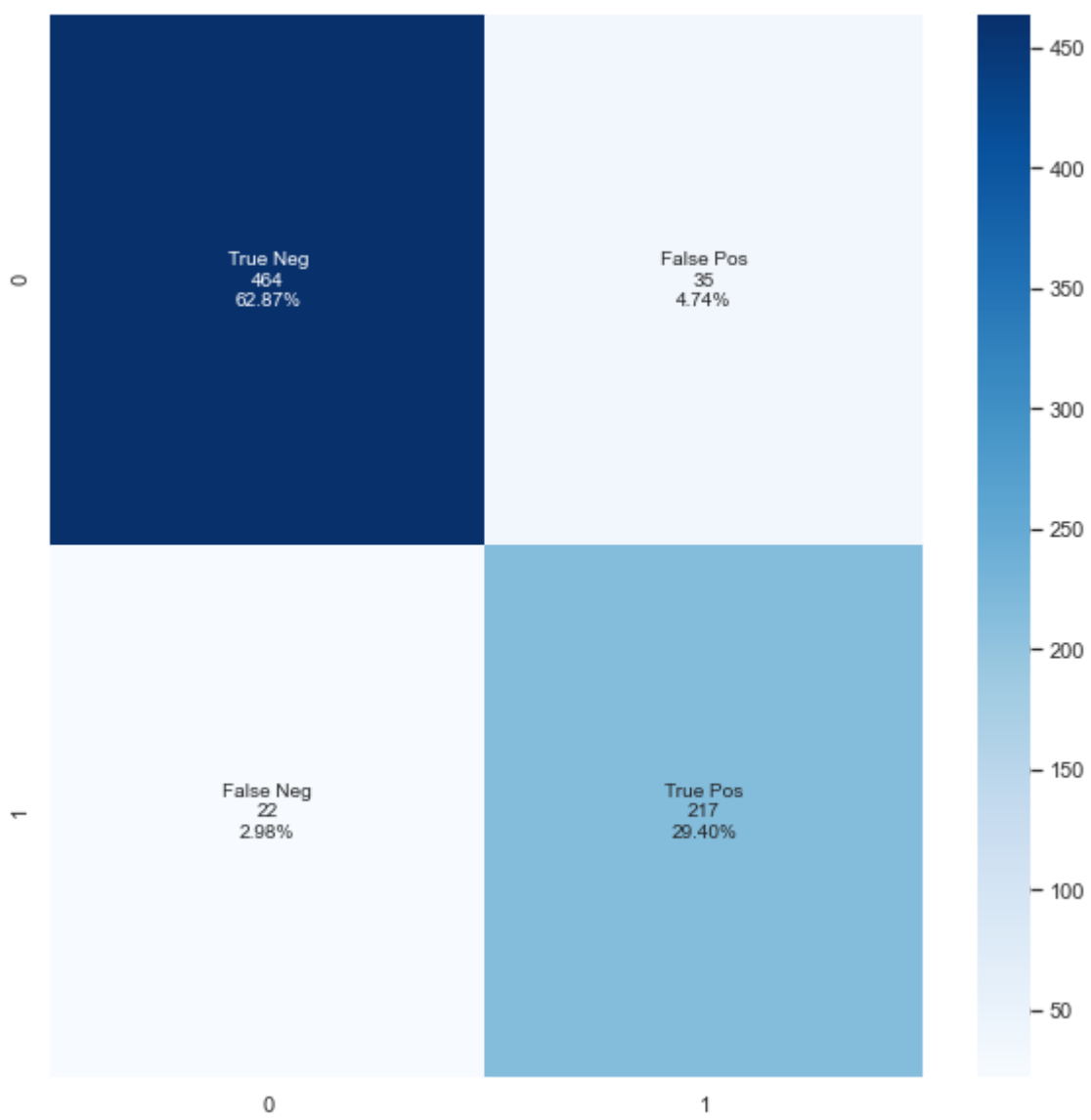
738 rows × 12 columns

In [114]:
```
cf_matrix = confusion_matrix(y_test, Predictions)
print(cf_matrix)
```

```
[[464  35]
 [ 22 217]]
```

In [115]:
```
fig, ax = plt.subplots(figsize=(10,10))
group_names = ["True Neg","False Pos","False Neg","True Pos"]
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten()/np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', ax=ax)
```

Out[115]:
```
<AxesSubplot:>
```


True Neg
464
62.87%
False Pos
35
4.74%
False Neg
22
2.98%
True Pos
217
29.40%
0
1
0
1
450
400
350
300
250
200
150
100
50

In [116]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

          No       0.95      0.93      0.94       499
         Yes       0.86      0.91      0.88       239

    accuracy                           0.92       738
   macro avg       0.91      0.92      0.91       738
weighted avg       0.92      0.92      0.92       738
```

In [117]:
```
Mapper={"Yes":1,"No":0}
```

In [118]:
```
y_test_temp=list(map(Mapper.get, y_test))
```

In [119]:
```
Predictions_temp=list(map(Mapper.get, Predictions))
```

In [120]:
```
This_3= roc_auc_score(y_test_temp, Predictions_temp)
```

In [121]:
```
print(f" AUC-ROC score is {This_3}")
```

```
 AUC-ROC score is 0.9189047551169285
```

In [122]:
```
fpr3, tpr3, _ = roc_curve(y_test_temp, Predictions_temp)
```

==========

Classification model 4 - We are using the imbalanced dataset as it is

==========

- Intent here is that our dataset is not balanced, and we are sampling and balancing it (For each positive sample, 2 negative samples

are chosen)

- Random Forest model is used
- Random Forest being a Decision tree based algorithm is found to generalise well to imbalance of dataset, so this model would be attempting to find evidence in that

In [ ]:

In [123]:
```
DF=DF_One.copy()
```

In [124]:
```
DF.Match.value_counts()
```

Out[124]:
```
No     11177
Yes      857
Name: Match, dtype: int64
```

In [125]:
```
DF.drop(columns="feature_transaction_id",inplace=True)
```

In [126]:
```
X=DF.iloc[:,:-1]
Y=DF.iloc[:,-1]
```

In [127]:
```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.30)
```

In [128]:
```
# smt = SMOTE(random_state=0)
# X_train_SMOTE, y_train_SMOTE = smt.fit_sample(X_train, y_train)
```

In [129]:
```
# X_train_SMOTE.shape,y_train_SMOTE.shape
```

In [ ]:

In [130]:
```
Model = RandomForestClassifier()
```

In [131]:
```
Model.fit(X_train,y_train)
```

Out[131]:
```
RandomForestClassifier()
```

In [132]:
```
print(f"Cross validation score of the model : {cross_val_score(Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.9456250970430311
```

In [133]:
```
#Model.fit(X_train_SMOTE,y_train_SMOTE)
```

In [134]:
```
Predictions=Model.predict(X_test)
```

In [135]:
```
X_test
```

Out[135]:

	receipt_id	company_id	matched_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	TimeMappingMatch
6671	30154.0	30000	30543.0	3	0	0	0
455	10040.0	10000	10399.0	0	0	0	0
10407	40216.0	40000	40231.0	0	0	0	0
9983	40074.0	40000	40046.0	0	0	0	0
6373	30133.0	30000	30756.0	3	0	0	0
...	...	...	...	...	...	...	...
950	10095.0	10000	10356.0	0	0	0	0
4552	20204.0	20000	20438.0	0	0	0	0
1948	10176.0	10000	10606.0	0	0	0	0
5850	30091.0	30000	30497.0	0	0	0	0
9901	40056.0	40000	40097.0	0	0	0	0

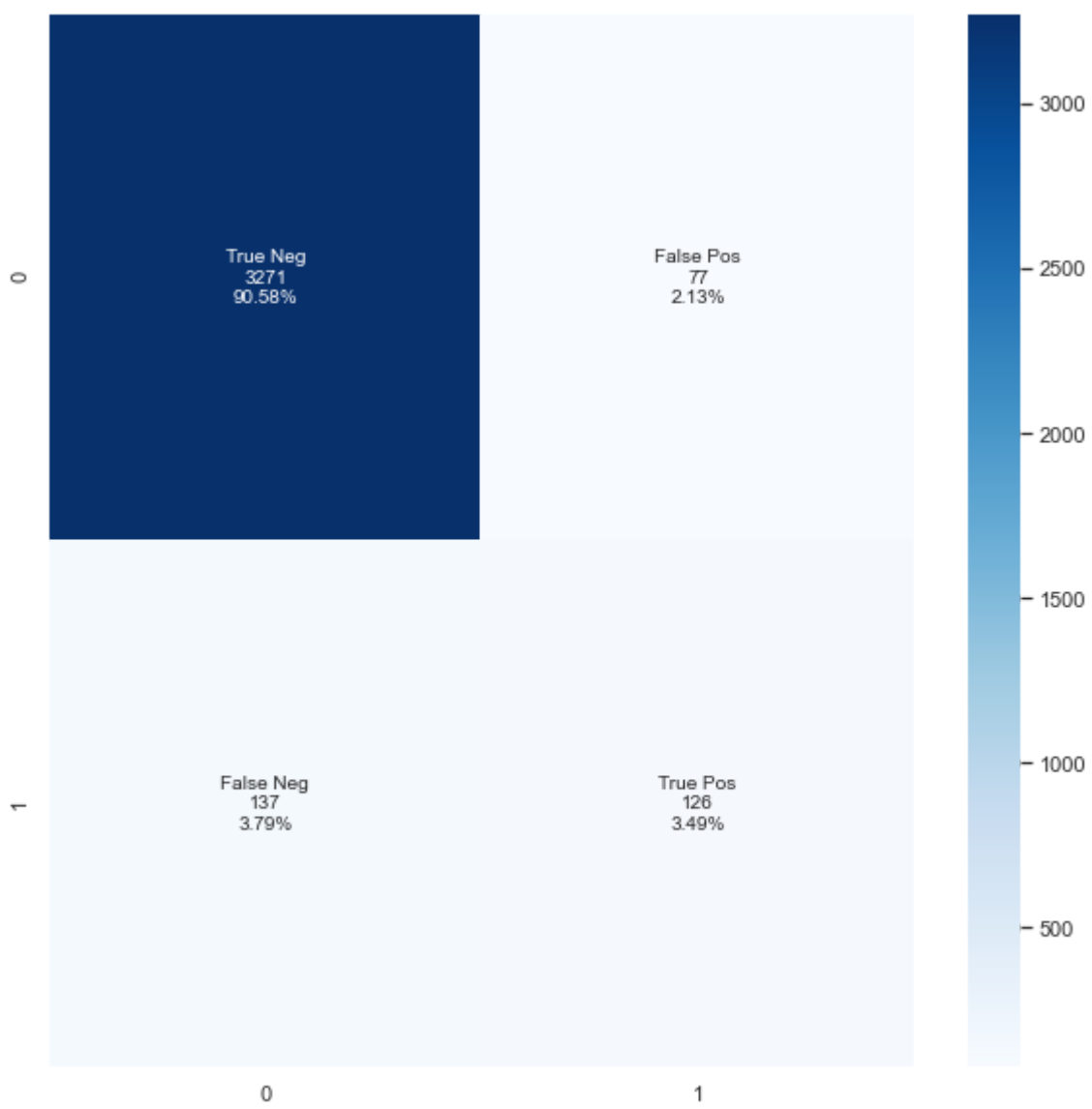
3611 rows × 12 columns

In [136]:
```
cf_matrix = confusion_matrix(y_test, Predictions)
print(cf_matrix)
```

```
[[3271   77]
 [ 137  126]]
```

In [137]:
```
fig, ax = plt.subplots(figsize=(10,10))
group_names = ["True Neg","False Pos","False Neg","True Pos"]
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten()/np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', ax=ax)
```

Out[137]:
```
<AxesSubplot:>
```


True Neg
3271
90.58%
False Pos
77
2.13%
False Neg
137
3.79%
True Pos
126
3.49%
0
1
0
1
3000
2500
2000
1500
1000
500

In [138]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

          No       0.96      0.98      0.97      3348
         Yes       0.62      0.48      0.54       263

    accuracy                           0.94      3611
   macro avg       0.79      0.73      0.75      3611
weighted avg       0.94      0.94      0.94      3611
```

In [139]:
```
Mapper={"Yes":1,"No":0}
```

In [140]:
```
y_test_temp=list(map(Mapper.get, y_test))
```

In [141]:
```
Predictions_temp=list(map(Mapper.get, Predictions))
```

In [142]:
```
This_4= roc_auc_score(y_test_temp, Predictions_temp)
```

In [143]:
```
print(f" AUC-ROC score is {This_4}")
```

```
 AUC-ROC score is 0.7280443236073065
```

In [144]:
```
fpr4, tpr4, _ = roc_curve(y_test_temp, Predictions_temp)
```

In [ ]:
```

```

==========

Classification model 5 - We are using the imbalanced dataset as it is, and using SMOTE

==========

- Intent here is that our dataset is not balanced, and we are sampling and balancing it (For each positive sample, 2 negative samples are chosen)
- Random Forest model is used
- We are using the SMOTE algorithm to oversample the minority class

In [ ]:

In [145]:
```
DF=DF_One.copy()
```

In [146]:
```
DF.Match.value_counts()
```

Out[146]:
```
No     11177
Yes      857
Name: Match, dtype: int64
```

In [147]:
```
DF.drop(columns="feature_transaction_id",inplace=True)
```

In [148]:
```
X=DF.iloc[:,:-1]
Y=DF.iloc[:,-1]
```

In [149]:
```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.30)
```

In [150]:
```
smt = SMOTE(random_state=0)
X_train_SMOTE, y_train_SMOTE = smt.fit_sample(X_train, y_train)
```

In [151]:
```
Model = RandomForestClassifier()
```

In [152]:
```
Model.fit(X_train_SMOTE,y_train_SMOTE)
```

Out[152]:
```
RandomForestClassifier()
```

In [153]:
```
print(f"Cross validation score of the model : {cross_val_score(Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.9440822256886895
```

In [154]:
```
Predictions=Model.predict(X_test)
```

In [155]:
```
X_test
```

Out[155]:

	receipt_id	company_id	matched_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	TimeMappingMatch	P
8968	30337.0	30000	31325.0	2	0	0	0	
9849	40046.0	40000	40333.0	3	0	0	0	
2731	20035.0	20000	20434.0	0	0	0	0	
5376	30054.0	30000	30678.0	3	0	1	0	
9664	40000.0	40000	40419.0	0	0	0	0	
...	...	...	...	...	...	...	...	...
740	10077.0	10000	10595.0	0	0	0	0	
7902	30252.0	30000	30791.0	0	0	0	0	
4210	20175.0	20000	20073.0	0	0	0	0	
5043	30028.0	30000	30884.0	0	0	0	0	
8986	30338.0	30000	30397.0	0	0	0	0	

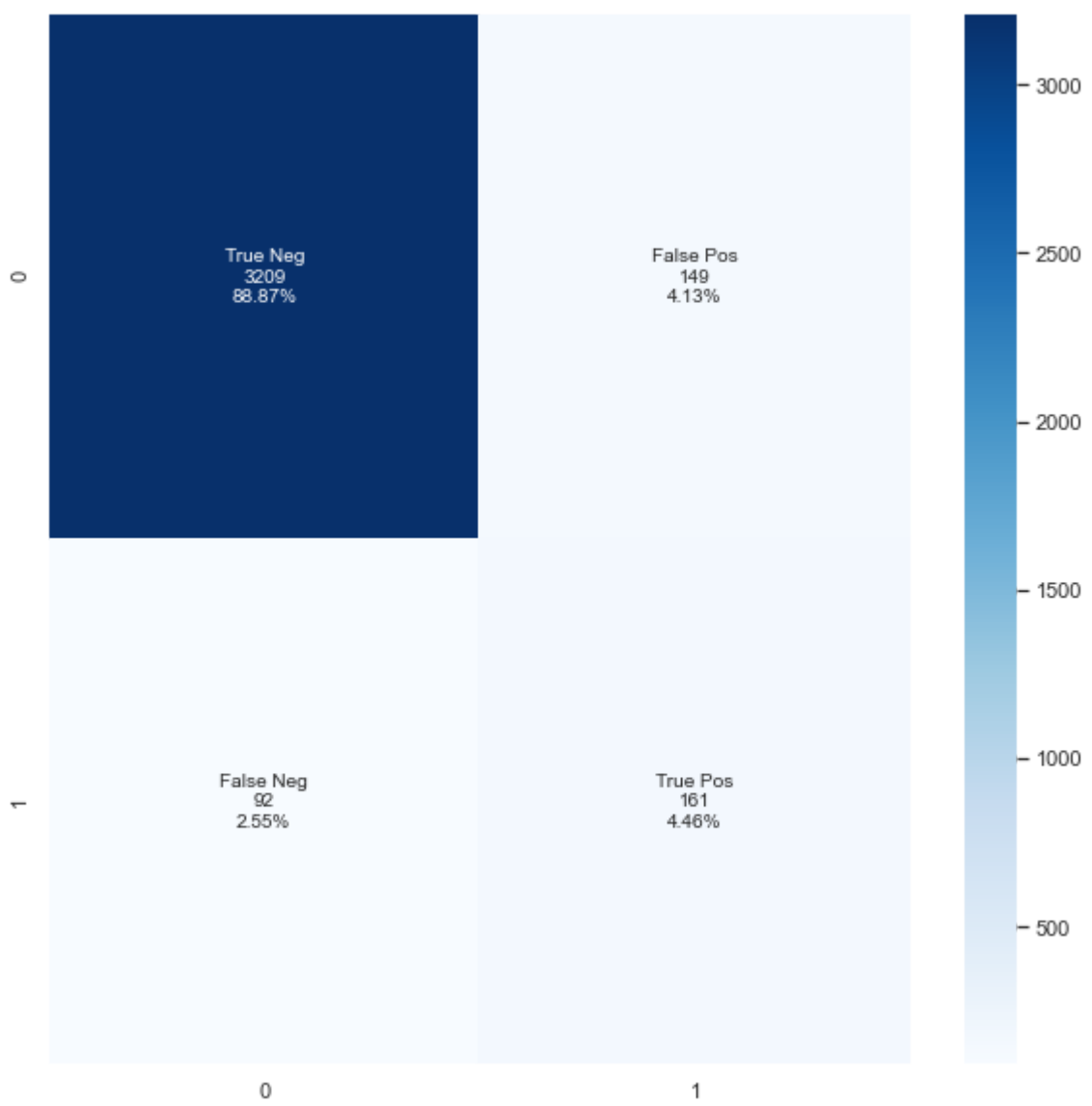
3611 rows × 12 columns

In [156]:
```
cf_matrix = confusion_matrix(y_test, Predictions)
print(cf_matrix)
```

```
[[3209  149]
 [  92  161]]
```

In [157]:
```
fig, ax = plt.subplots(figsize=(10,10))
group_names = ["True Neg","False Pos","False Neg","True Pos"]
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten()/np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', ax=ax)
```

Out[157]:
```
<AxesSubplot:>
```


True Neg
3209
88.87%
False Pos
149
4.13%
False Neg
92
2.55%
True Pos
161
4.46%
0
1
0
1
3000
2500
2000
1500
1000
500

In [158]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

          No       0.97      0.96      0.96      3358
         Yes       0.52      0.64      0.57       253

    accuracy                           0.93      3611
   macro avg       0.75      0.80      0.77      3611
weighted avg       0.94      0.93      0.94      3611
```

In [159]:
```
Mapper={"Yes":1,"No":0}
```

In [160]:
```
y_test_temp=list(map(Mapper.get, y_test))
```

In [161]:
```
Predictions_temp=list(map(Mapper.get, Predictions))
```

In [162]:
```
This_5= roc_auc_score(y_test_temp, Predictions_temp)
```

In [163]:
```
print(f" AUC-ROC score is {This_5}")
```

```
 AUC-ROC score is 0.7959959932860469
```

In [164]:
```
fpr5, tpr5, _ = roc_curve(y_test_temp, Predictions_temp)
```

In [ ]:
```

```

==========

Classification model 5 - We are using the imbalanced dataset and PCA is performed

==========

- Intent here is that our dataset is not balanced, and we are sampling and balancing it (For each positive sample, 2 negative samples are chosen)
- Random Forest model is used
- PCA is used to find 95% variance and distribution of that along the features

In [ ]:

In [165]:
```
DF=DF_One.copy()
```

In [166]:
```
DF.Match.value_counts()
```

Out[166]:
```
No     11177
Yes      857
Name: Match, dtype: int64
```

In [167]:
```
DF.drop(columns="feature_transaction_id",inplace=True)
```

In [168]:
```
X=DF.iloc[:,:-1]
Y=DF.iloc[:,-1]
```

In [169]:
```
X.head(3)
```

Out[169]:

	receipt_id	company_id	matched_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	TimeMappingMatch	Predi
0	10000.0	10000	10468.0	0	0	0	0	
1	10000.0	10000	10468.0	0	0	0	0	
2	10000.0	10000	10468.0	0	0	0	0	

In [170]:
```
Scaler=StandardScaler()
```

In [171]:
```
Scaled=Scaler.fit_transform(X)
```

In [174]:
```
pca = PCA(.95)
principalComponents = pca.fit_transform(Scaled)
#principalDf = pd.DataFrame(data = principalComponents
```

In [175]:
```
X_train, X_test, y_train, y_test = train_test_split(principalComponents, Y, test_size=0.30)
```

In [176]:
```
Model = RandomForestClassifier()
```

In [177]:
```
Model.fit(X_train,y_train)
```

Out[177]:
```
RandomForestClassifier()
```

In [178]:
```
print(f"Cross validation score of the model : {cross_val_score(Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.9425377745640737
```

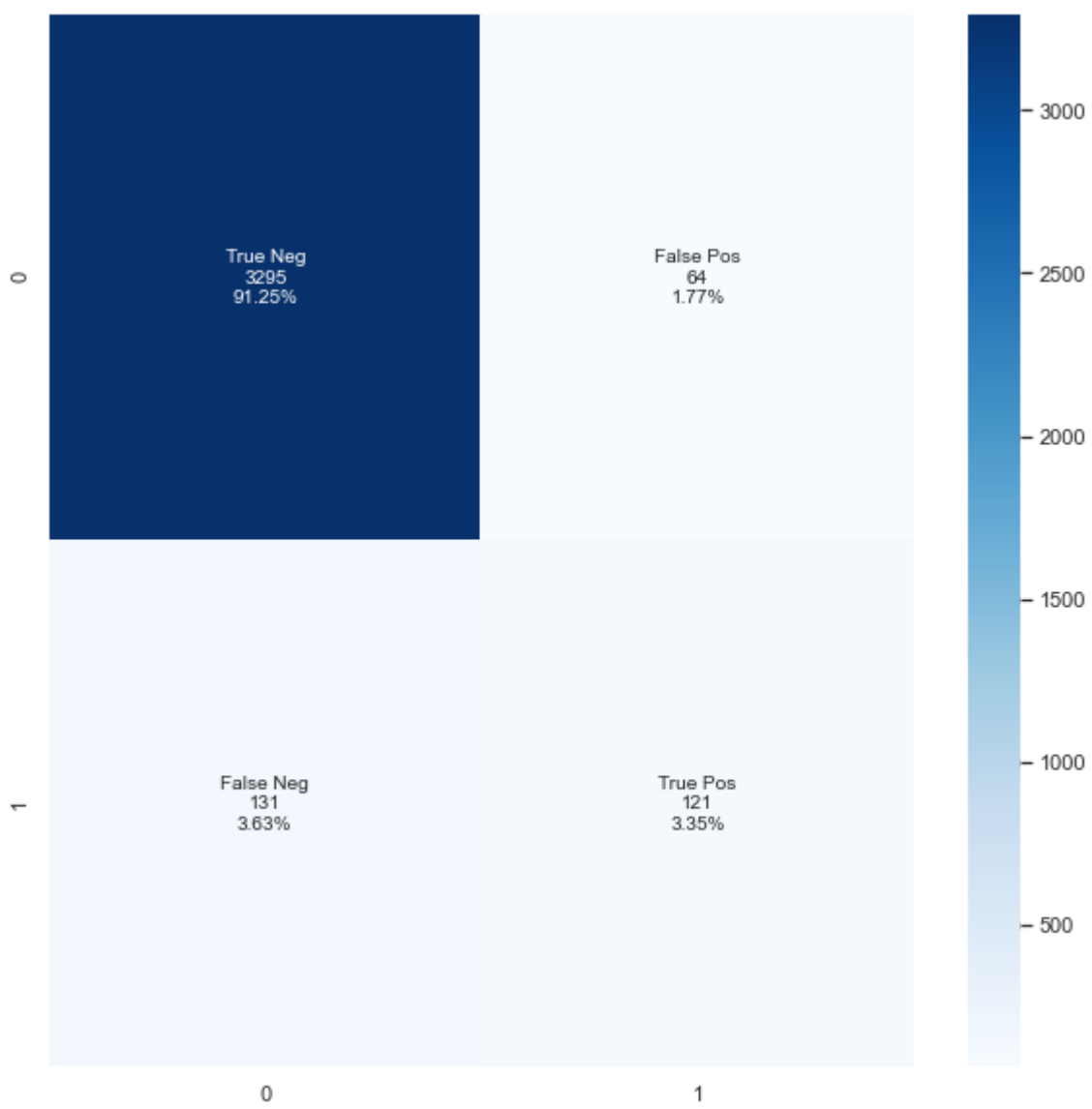
In [179]:
```
Predictions=Model.predict(X_test)
```

In [180]:
```
cf_matrix = confusion_matrix(y_test, Predictions)
print(cf_matrix)
```

```
[[3295   64]
 [ 131  121]]
```

In [181]:
```
fig, ax = plt.subplots(figsize=(10,10))
group_names = ["True Neg","False Pos","False Neg","True Pos"]
group_counts = ["{0:0.0f}".format(value) for value in
                cf_matrix.flatten()]
group_percentages = ["{0:.2%}".format(value) for value in
                     cf_matrix.flatten()/np.sum(cf_matrix)]
labels = [f"{v1}\n{v2}\n{v3}" for v1, v2, v3 in
          zip(group_names,group_counts,group_percentages)]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cf_matrix, annot=labels, fmt='', cmap='Blues', ax=ax)
```

Out[181]:
```
<AxesSubplot:>
```


True Neg
3295
91.25%
False Pos
64
1.77%
False Neg
131
3.63%
True Pos
121
3.35%
0
1
0
1
3000
2500
2000
1500
1000
500

In [182]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

          No       0.96      0.98      0.97      3359
         Yes       0.65      0.48      0.55       252

    accuracy                           0.95      3611
   macro avg       0.81      0.73      0.76      3611
weighted avg       0.94      0.95      0.94      3611
```

In [183]:
```
Mapper={"Yes":1,"No":0}
```

In [184]:
```
y_test_temp=list(map(Mapper.get, y_test))
```

In [185]:
```
Predictions_temp=list(map(Mapper.get, Predictions))
```

In [186]:
```
This_6= roc_auc_score(y_test_temp, Predictions_temp)
```

In [187]:
```
print(f" AUC-ROC score is {This_6}")
```

```
 AUC-ROC score is 0.7305527202445928
```

In [188]:
```
fpr6, tpr6, _ = roc_curve(y_test_temp, Predictions_temp)
```

In [ ]:
```

```

==========

Comparing AUC-ROC curves

==========

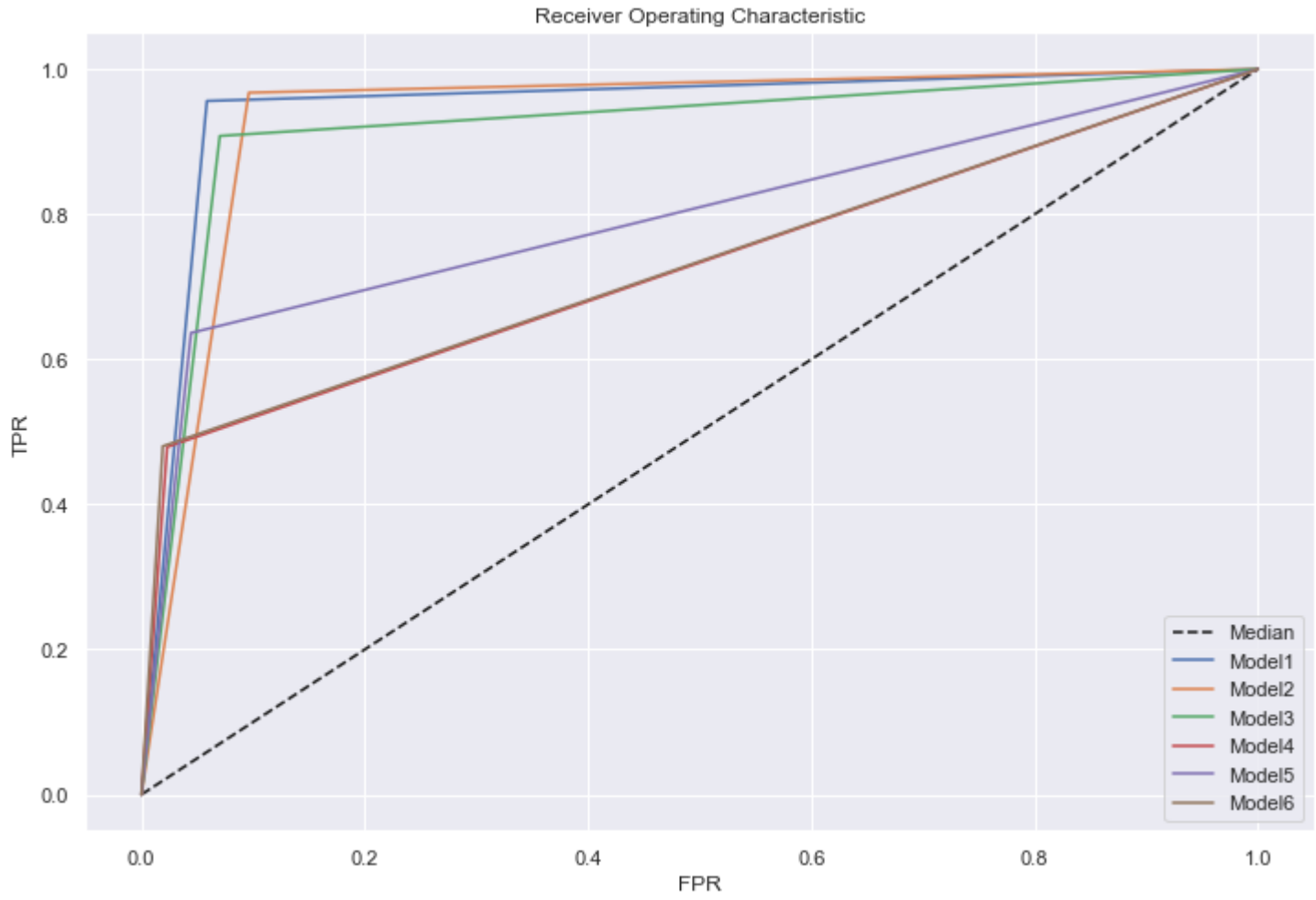
- Here we are comparing all the models on the basis of their AUC-ROC curves

LEGEND

- Model 1 - Sampled equally, using all features
- Model 2 - Sampled equally, using Weightage column (Other features dropped)
- Model 3 - Sampled in 1:2 ratio (One positive would have 2 Negative samples)
- Model 4 - No sampling, all data is used
- Model 5 - No sampling, all data is used using SMOTE to account for imbalance
- Model 6 - No sampling, PCA is used

In [ ]:

In [189]:
```
plt.figure(figsize=(12,8))
plt.plot([0,1],[0,1], 'k--', label="Median")
plt.plot(fpr1, tpr1, label= "Model1")
plt.plot(fpr2, tpr2, label= "Model2")
plt.plot(fpr3, tpr3, label= "Model3")
plt.plot(fpr4, tpr4, label= "Model4")
plt.plot(fpr5, tpr5, label= "Model5")
plt.plot(fpr6, tpr6, label= "Model6")
plt.legend()
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title('Receiver Operating Characteristic')
plt.show()
```



- **Inference** - Based on the AUC ROC curves above, I have elected to proceed with Model 2, which was sampled equally (Trained on equal data *(Positive and Negative)* sampled from the dataset provided)

Note : However, based on the use case, other models can be employed. This depends more on what sort of a business objective you're trying to focus toward

In [ ]:

==========

Prediction Model, consuming Model 1

==========

- Here we are using Model 1 from above
- We are defining a function which takes in data and does all pre-processing steps
- Then as an output, we are returning a Dataframe which is sorted by Weightage

In [190]:
```
def Preprocess(Data):
    Binaries = ['DifferentPredictedDate','PredictedTimeCloseMatch','ShortNameMatch','TimeMappingMatch']
    Needed=['AmountMappingMatch',
            'PredictedNameMatch',
            'PredictedAmountMatch',
            'DescriptionMatch',
            'DateMappingMatch']

    if "DifferentPredictedTime" in Data.columns:
        Data.drop(columns="DifferentPredictedTime",inplace=True)

    if "feature_transaction_id" in Data.columns:
        Data.drop(columns="feature_transaction_id",inplace=True)

    if not Data.matched_transaction_id.dtype=='float64':
        Data.matched_transaction_id=Data.matched_transaction_id.str.replace(',', '').astype(float)
    #if not Data.feature_transaction_id.dtype=='float64':
        #Data.feature_transaction_id=Data.feature_transaction_id.str.replace(',', '').astype(float)
    if not Data.receipt_id.dtype=='float64':
        Data.receipt_id=Data.receipt_id.str.replace(',', '').astype(float)

    for x in Binaries:
        Data[x]=Data[x].astype('category').cat.codes
    for x in Needed:
        Data[x]=pd.cut(Data[x], bins=[-1, .4, .6, .8, 1])
        Data[x]=Data[x].cat.codes
    Data["Weightage"]=Data.DateMappingMatch+Data.AmountMappingMatch+Data.DescriptionMatch+Data.TimeMappingMatch+
    #print(Data.columns)
    Predictions=Final_Model.predict(Data.iloc[:,:-1])
    Data["Match"]=Predictions
    Data=Data.sort_values(by=["matched_transaction_id","Weightage"], ascending =[True, False])
    return Data
```

In [191]:
```
Data=pd.read_csv("./Desktop/Tide_test_DS/Tide_test_DS/data_interview_test.csv",sep=":",nrows=200)
```

In [ ]:
```

```

In [192]:
```
Required=Preprocess(Data)
```

In [193]:
```
Required.tail(20)
```

Out[193]:

	receipt_id	company_id	matched_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch	TimeMappingMatch	Pr
22	10001.0	10000	10605.0	0	0	0	0	
23	10001.0	10000	10605.0	0	0	0	0	
24	10001.0	10000	10605.0	0	0	0	0	
170	10011.0	10000	10659.0	3	0	0	0	
165	10011.0	10000	10659.0	2	0	1	0	
169	10011.0	10000	10659.0	3	0	0	0	
163	10011.0	10000	10659.0	2	0	0	0	
164	10011.0	10000	10659.0	2	0	0	0	
154	10011.0	10000	10659.0	0	0	0	0	
155	10011.0	10000	10659.0	0	0	0	0	
156	10011.0	10000	10659.0	0	0	0	0	
157	10011.0	10000	10659.0	0	0	0	0	
158	10011.0	10000	10659.0	0	0	0	0	
159	10011.0	10000	10659.0	0	0	0	0	
160	10011.0	10000	10659.0	0	0	0	0	
161	10011.0	10000	10659.0	0	0	0	0	
162	10011.0	10000	10659.0	0	0	0	0	
166	10011.0	10000	10659.0	0	0	0	0	
167	10011.0	10000	10659.0	0	0	0	0	
168	10011.0	10000	10659.0	0	0	0	0	

In [ ]:
```

```

==========

Alternative approach

==========

- Here are using a Scoring criteria to train a model
- The idea here is to create Scores for each data row, which is a cumulative of all the Matched probabilities
- Scoring for matched rows is given as a maximum (10)
- This Scoring column is the Label
- Model is trained in this manner

In [194]:
```
DF=DF_One.copy()
```

In [195]:
```
DF.Match.value_counts()
```

Out[195]:
```
No     11177
Yes      857
Name: Match, dtype: int64
```

In [ ]:
```

```

In [196]:
```
#DF["Scoring"]=DF.DateMappingMatch+DF.AmountMappingMatch+DF.DescriptionMatch+DF.TimeMappingMatch+DF.PredictedNam
```

In [197]:
```
DF["Scoring"]=np.where(DF.Match=="Yes", 10,DF.DateMappingMatch+DF.AmountMappingMatch+DF.DescriptionMatch+DF.Time
```

In [198]:
```
DF.Scoring.value_counts()
```

Out[198]:
```
1     8286
3     1765
10     857
2      764
4      254
5       73
6       27
7        8
Name: Scoring, dtype: int64
```

In [199]:
```
#DF.iloc[:,:-2]
```

In [200]:
```
X=DF.iloc[:,:-2]
Y=DF.Scoring
```

In [201]:
```
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.30)
```

In [202]:
```
Temp=X_test.copy()
```

In [203]:
```
X_train.drop(columns="feature_transaction_id",inplace=True)
X_test.drop(columns="feature_transaction_id",inplace=True)
```

In [204]:
```
# smt = SMOTE(random_state=0)
# X_train_SMOTE, y_train_SMOTE = smt.fit_sample(X_train, y_train)
```

In [205]:
```
# X_train_SMOTE.shape,y_train_SMOTE.shape
```

In [206]:
```
#y_test.value_counts()
```

In [207]:
```
Final_Model = RandomForestClassifier()
```

In [208]:
```
Final_Model.fit(X_train,y_train)
```

Out[208]:
```
RandomForestClassifier()
```

In [209]:
```
print(f"Cross validation score of the model : {cross_val_score(Final_Model, X_train, y_train, cv=8).mean()}")
```

```
Cross validation score of the model : 0.9432510408429293
```

In [210]:
```
#Model.fit(X_train_SMOTE,y_train_SMOTE)
```

In [211]:
```
Predictions=Final_Model.predict(X_test)
```

In [212]:
```
Temp["Preds"]=Predictions
Temp["Actual"]=y_test
```

In [228]:
```
# Recommendations would look like this
```

In [231]:
```
Temp[Temp.matched_transaction_id==30398.0].sort_values(by=["matched_transaction_id","Preds"], ascending=[True, F
```

Out[231]:

	receipt_id	company_id	matched_transaction_id	feature_transaction_id	DateMappingMatch	AmountMappingMatch	DescriptionMatch
7311	30203.0	30000	30398.0	30397.0	3	0	0
7312	30203.0	30000	30398.0	30398.0	3	0	0
7310	30203.0	30000	30398.0	30396.0	3	0	0
7301	30203.0	30000	30398.0	30387.0	0	0	0
7302	30203.0	30000	30398.0	30388.0	0	0	0
7295	30203.0	30000	30398.0	30255.0	0	0	0
7299	30203.0	30000	30398.0	30383.0	0	0	0
7305	30203.0	30000	30398.0	30391.0	0	0	0
7297	30203.0	30000	30398.0	30257.0	0	0	0
7296	30203.0	30000	30398.0	30256.0	0	0	0
7307	30203.0	30000	30398.0	30393.0	0	0	0

In [213]:
```
cf_matrix = confusion_matrix(y_test, Predictions,labels=list(set(y_test)))
#print(cf_matrix)
```

In [214]:
```
df_cm = pd.DataFrame(cf_matrix, columns=list(set(y_test)),index=list(set(y_test)))
#df_cm
plt.figure(figsize = (14,9))
sns.heatmap(df_cm, annot=True,cmap='Blues')
```

Out[214]: <AxesSubplot:>

In [215]:
```
print(classification_report(y_test, Predictions))
```

```
              precision    recall  f1-score   support

           1       1.00      1.00      1.00      2494
           2       0.97      1.00      0.98       225
           3       0.85      0.91      0.88       528
           4       0.56      0.64      0.60        69
           5       0.83      0.53      0.65        19
           6       0.33      0.29      0.31         7
           7       0.12      0.33      0.18         3
          10       0.65      0.53      0.59       266

    accuracy                           0.94      3611
   macro avg       0.67      0.65      0.65      3611
weighted avg       0.94      0.94      0.94      3611
```

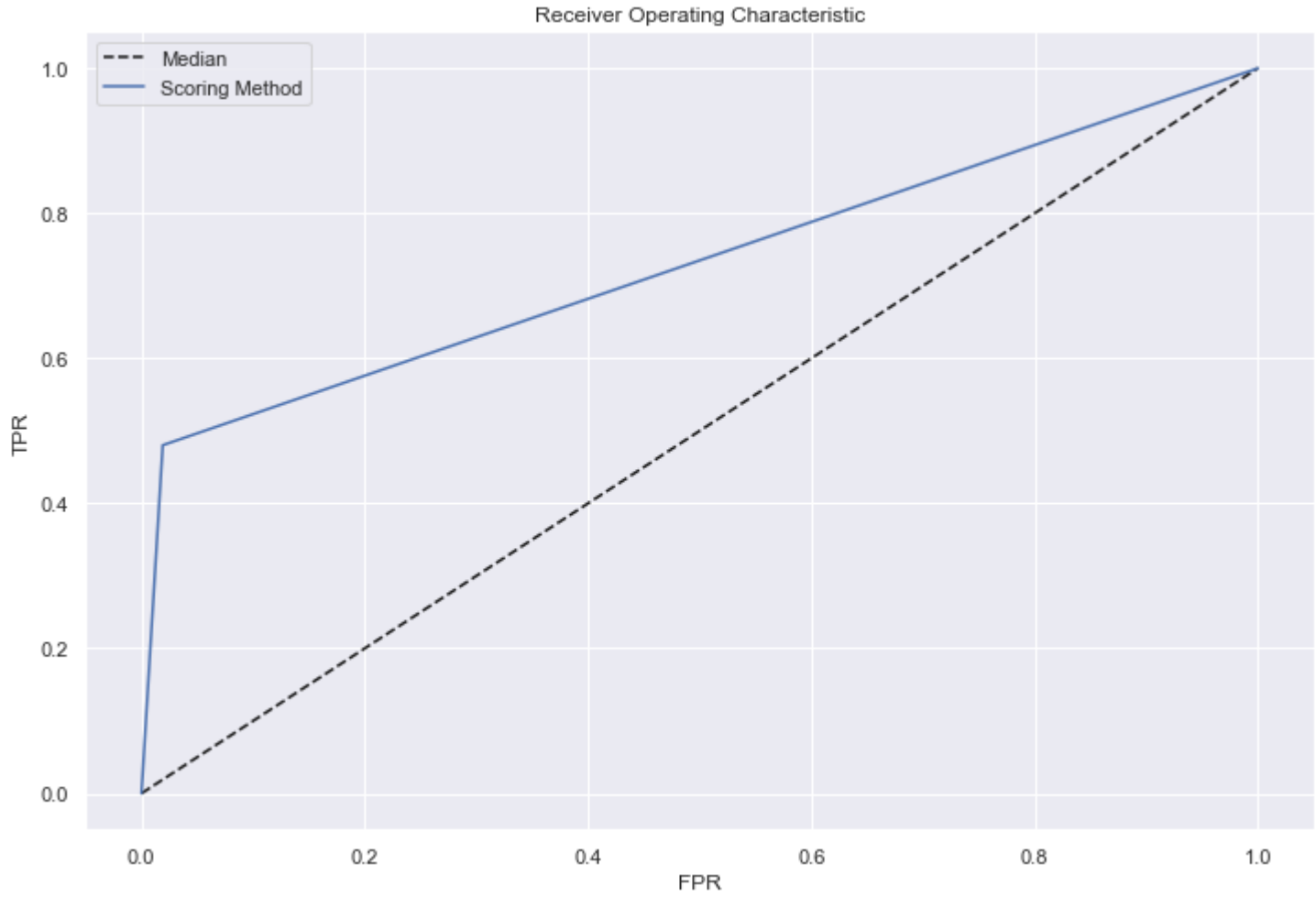
In [216]:
```
This_1= roc_auc_score(y_test_temp, Predictions_temp)
```

In [217]:
```
print(f" AUC-ROC score is {This_1}")
```

```
 AUC-ROC score is 0.7305527202445928
```

In [218]:
```
fpr1, tpr1, _ = roc_curve(y_test_temp, Predictions_temp)
```

In [219]:
```
plt.figure(figsize=(12,8))
plt.plot([0,1],[0,1], 'k--', label="Median")
plt.plot(fpr1, tpr1, label= "Scoring Method")

plt.legend()
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title('Receiver Operating Characteristic')
plt.show()
```



In [ ]:

- The above model is also showing significant results, however we've added more classes to the model
- The idea here is to create Scores for each data row, which is a cumulative of all the Matched probabilities
- Scoring for matched rows is given as a maximum (10)
- This Scoring column is the Label
- Model is trained in this manner

Final Inference -

- We can combine both these models to come up with a model which uses the best of both worlds, however for the interest of time this is not done

In [ ]: